Need for Study and Career Counselling in Computer Science

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Abstract - High drop-out rates among undergraduate students of Computer Science (CS) can be explained by low study motivation. One way to increase students’ motivation is to support their professional orientation and identity by various study and career counselling methods. A survey of Finnish CS students’ awareness of their career choices and evaluation of undergraduate courses from the viewpoint of professional benefit, as well as an analysis of a group counselling module organized for first-year students, indicate that CS education can be improved not only by intensifying the professional aspects of individual courses, but also by including study and career counselling modules as integrating components of the whole CS curriculum.

Index Terms –counselling, CSE, curriculum, IT education, occupation, pedagogy

INTRODUCTION

I. Guidance and Counselling in CSE

The uncertainty of professional identity and future career prospects have enormously increased in higher education. Particularly in the field of Information Technology (IT), fast and mostly unexpected technical advances as well as rapid changes in working life require abilities to cope with uncertainty. However, although they are the main agents in training IT professionals, most Computer Science programs pay little if any attention to the critical field of educational counselling. [see 1-7]

Guidance and counselling in higher education provides support and aid to students in their learning, studies and life-situations. Higher education guidance services have typically been concerned with study skills and other forms of academic guidance. Too little attention has been paid to career guidance or the career implications of course choices. [8]

Recent research on guidance in higher education considers these career questions as part of the student’s life situation and future plans as a whole. The questions of career guidance seem to be present from the beginning of the study path. When students start to construct the first elements of their professional identity at the outset of their studies, they also raise questions about whether they study in the most appropriate field.

Students can also feel uncertainty about whether they have chosen a field of study that suits them in terms of their interests and abilities. They have expressed uncertainty concerning the occupations their degree program prepares them for. This might also reflect the fact that for most of the Finnish undergraduate students in CS or science in general, the major subject was not really their first choice which makes them to use the first year to consider other choices, and attend their courses. The uncertainty of science students in their future career might also be understood by the public discussion of the need for top research units and centres of excellences: an ordinary student might not be able to identify him/her in these goals. This might also be a reason for the well-known recruitment problems in science: science or CS is for others.

Furthermore, university students might wonder whether they acquire the knowledge and skills needed in working life. This seems to be particularly true of those CS students who are more confident in their study choice. It makes them to try out part-time jobs from a very early stage of their studies. Over the years, they might start a full-time IT job and never graduate. The commitment to IT does not realize though studies but work.

The challenges of higher education, especially from the perspective of working life, pose new challenges to guidance and counselling. These findings are also reported in respect to the field of IT education. [4]

Attention should be paid to the development of holistic student-centred guidance in IT education. The holistic model stresses the relationships between educational, career and personal guidance. Though the model is divided in three areas of student support, it emphasizes the way how these areas interact with each other. Students who lack career maturity might benefit interventions of educational and personal guidance. Accordingly, educational guidance can facilitate the methods used in career guidance. This pays attention to the need of career decision and planning overlapping the educational guidance in higher education. Also the awareness of issues of personal guidance
can consider to be part of career planning.[3] In this student-centered model the various levels of the guidance and counselling system co-operate in order to respond to the guidance and counselling needs of students [4].

This study reports the first findings of a longer term initiative to develop Computer Science studies towards a motivating learning path. Counselling is expected to raise students’ awareness of their future career and their required competences, as well as to support teachers’ sensitivity and creativity to link their courses to working life. In order to guarantee rigorous analysis and interpretation of the results and make the outcomes relevant to the computing field, the initiative is carried out as an interdisciplinary research project where experts from Computer Science and Counselling work tightly together.

The counselling project in CS education is a subproject of the ‘Group counselling in the era of change and uncertainty: Navigating forward’ project. The main goals of this larger group counselling project are to 1) pilot group counselling models in schools, higher education and workplaces, 2) study the processes of group sessions and the experiences of the participants and group counsellors, and 3) evaluate the cultural contexts and requisites of group-counselling practices in different settings.

II. Related Literature


Counselling and guidance research has only been done in CS to a limited extent. There is a great deal of research on how to teach so that students can take advantage of it, but real counselling has been studied far less. Many methods have been designed to help novice programmers become professionals, but there is no total guidance for their studies - each manages as she/he can. In case students need advice, they should ask for help, but usually do not.

While there are fewer students than in earlier days, counselling is needed more. There is less competition and it is more difficult to get well-motivated students, and the drop-out rate of the heterogeneous student population has increased. [9,10] The same phenomenon has occurred in Europe and the US.

Denning [11] asks what students should know about their future profession or their major subject. He states that they should be aware that there are numerous jobs that do not concern programming. However, everybody should know how to program in some programming language (although challenging to learn, Java and C++ have become popular as the first programming language).

Kolb’s index has been used to measure conative talents of students at the beginning of their CS studies. Typical CS students were fact-finders with follow-through instincts. It seemed that strong implementers were most likely to leave CS programs. The best team results, however, require all types of talents, so quick starters and implementers are also needed. Guidance must be given to them to insure they remain CS students. [12]

Some research on student retention in CS has been done [12]. Negative attitudes, for example, towards programming need to become more positive. The students’ own abilities to cope with computers are one major concern [13]. Emotional intelligence has also been studied [12,14] among computer science students and those who are not. Self-efficacy was revealed to be greater among CS students who coped with their studies. Research projects made students more familiar with research and staff and helped retain them [10]. Gender has become distorted as fewer women remain in Computer Science.

EMPIRICAL APPROACH

The context of the counselling project is CS-education in the University of Joensuu. The Department of Computer Science is one of the biggest at the university with a faculty and staff of 25 people. Over the past years, the number of first-year undergraduate students has fallen from 80 to 30.

The group counselling project aims to develop the guidance and counselling services as an integrated part of the whole CS curriculum.

I. Group Counselling Project in Computer Science

The project in CS education at the University of Joensuu consisted of the three following stages:

Stage I: The research question asked what the study paths of CS students are like. By means of different student information systems we examined the study progress of the CS students admitted in 2004, 2005, and 2006. On the basis of the data obtained we were able to divide the students into eight groups according to the progress of their studies. This stage provided us with background information.

Stage II: The research question involved how CS students find their way into the field and what their orientation to their studies is like. On the basis of an earlier survey, a questionnaire (an e-form) was drawn up and sent to all CS majors. During late autumn 2007 and spring 2008, a total of 59 students responded to the questionnaire. Its questions concerned how they found their way into CS studies, their knowledge of the field, their study styles, the goals of their studies and their work, and the progress of their studies. Later, some of the students were interviewed. In addition, another questionnaire was given to first-year students and sought to gain information about how satisfied the students were with their courses.

Stage III: The goal was to develop models of group counselling applicable to CS students. The research question was how group counselling can be used to promote the students’ agency in relation to their studies and future careers. The first pilot was carried out in the academic year...
II. Developing Guidance Services in CS education in the University of Joensuu

The present guidance services are as follows: While at university, guidance for CS students occurs at the beginning of studies and is usually done by tutor teachers. There are also older students selected to act as tutors during the fall for first-year students. Tutors are trained for their jobs and then introduce teaching venues and also support freshmen in their university studies. Teachers usually advise students if the students come to them. This does not appear to be sufficient since so many students have rather odd or incorrect expectations about their studies.

Every student first makes a personal study plan (PSP) for the Bachelor’s and then the Master’s degree. There seems to be numerous difficulties in writing the PSP. Students have to choose minor subject(s) and make a rough study plan for the first three years. Computer Science students usually do not know which subject they want to study. However, they want to have a career after university and benefit from minor subjects. Their main subject is selected, but sometimes they think they do not need to study it at all; they might do studies in, say, Education and apply to Teacher Education after their first year.

As a novelty in the academic year 2007-2008 we offered new support elements. There was a welcoming evening for students and staff members. After the two first months, or the first of four periods in the academic year, the department organized an informal feedback and research group integration session for students. The feedback was processed and sent anonymously to the teachers, and some parts of the courses in the following period were slightly modified according to the feedback. During the last period of the academic year, we arranged a second feedback event. One teacher was also the contact person for the informal feedback throughout the year.

RESULTS

The results are based on questionnaires for advanced students (I) and for first-year students (II), and group counselling for first-year CS students (III). (See Figure 1.)

I. Survey-based Results

The purpose of the survey was to gain insight into the world of students studying computer science. We asked them to answer questions concerning their earlier studies, factors which influenced their decision to choose this particular field, what they know about studies in computer science, goals related to studying and working in the field, how their studies are progressing, their perception of how the studies have been organized, how useful the studies are in light of their personal professional development and how they feel about 16 IT occupations selected for this survey. Furthermore, we investigated learning styles and self-efficacy using standard inventories. The students were also asked when they expect to graduate, what they think their work situation will be like two years after graduation and what tasks they think they will have in their future working life. Finally, they were asked to provide feedback on the education offered by the department.

The questionnaire was sent to about 300 CS students in 2007 – 2008. A total of 59 (20%) responded. The request to answer the questionnaire was first sent by e-mail and later data was collected during the courses. Students most commonly filled out the questionnaire during lectures, and therefore the students who participated in the survey mainly represent those who actively study CS.

A total of 81% of those who participated in the survey were male and 19% female. Their ages ranged from 19 to 47 (mean 27 years, median 24 years). Since students in Finland can study as long as they like, there were differences in the duration of their studies: Two had started their studies in 1983, some between 1995 and 2002, half in 2003 or later. Those who started in 1983 graduated in summer 2008 and were excluded from that part of the questionnaire which concerned the analysis of the curriculum. Most of those who answered the survey were from the province surrounding the university (58 %), the rest from other parts of Finland. 25% had prior degrees from a university or a polytechnic. A third of those who participated in the survey had studied CS before.

Seven statements were made to students concerning what they knew about studies in Computer Science. The students considered their knowledge of the content and requirements of the studies to be limited or insufficient, the statement regarding financing of studies notwithstanding. The students evaluated the usefulness of different Computer Science courses when considering their professional
development. Courses related to programming and programming work were considered the most useful. Courses related to computation and mathematics were considered the least useful. Statements regarding the organization of studies indicated that it is necessary to develop the curriculum, the structure of the studies and student counselling during the entire study path.

The students responded to how they feel about 16 IT occupations (Figure 2). They considered their knowledge of different occupations insufficient, excluding programming work. Their interests in the occupations were quite low. The only occupations that intrigued the students were project manager and systems designer, which interested about half of them (Figure 3).

The students' goals were examined by using the Personal Projects Method [15]. The main goal related to studying was graduation (n = 45). Two-thirds of the students were satisfied with their choice of studies; three-fourths believed they would graduate from the Department of Computer Science. Two-thirds of the students expected that they would graduate between 2008 and 2010, one-third between 2011 and 2013. The main goal related to working life was getting a job (N=35). 45% of the students believed they would be permanently employed two years after graduation, 40% for a fixed-period and 15% in short or part-time employment. Two-thirds believed they would be employed in the field of IT; others had no clear image of how they would be employed.

The students' learning styles were assessed using the 32-Item Inventory [16], which provides a profile of the student's deep or surface processing learning style. It is worth noting that surface learning was a common style used by the students. It is an additional research topic to analyze more carefully the connection between learning styles and how studies progress.

II. Results Related to the First-Year Students' Questionnaire

We also asked the first-year students about their satisfaction with courses. Satisfaction was assessed e.g. on the basis of learning materials, course content and applicability of skills. The courses were: Introduction to CS, Introduction to Programming, Discrete Structures, Computer Systems, Data Structures and Algorithms 1 and Human-Computer Interaction. Selected questions are listed in Table I.
It was quite surprising that e.g. the best results for theme 2 ('course content was useful') were obtained for the rather theoretical Data Structures and Algorithms 1 course. For theme 4 ('I was encouraged to apply the skill and knowledge learned'), the lowest marks were for the online course Human-Computer Interaction.

There were also open questions related to counselling during the first year of study. Students provided positive feedback on several elements, but some responses indicated a need for more active guidance: the staff members could be active tutors or mentors especially during the first weeks of each period. They also suggested the organization of a more active tutors or mentors especially during the first weeks of each period. They also suggested the organization of a more basic level introductory course to IT and more contact-based courses. On the other hand, online informal guidance by older students via IRC was appreciated.

### III. Group Counselling

The aim of this study was to explore group counselling discussions as an opportunity to construct the student’s identity as a future expert in IT. A further goal of this stage of the research project was to develop a model for new practices of study and career counselling within the CS curriculum.

The group counselling experiment used the structured group counselling model [20]. There were two seven persons’ groups of first-year CS students in 2007-2008. The groups had two counsellors, a professional CS teacher and a study counsellor. Seven group counselling sessions were video-recorded and transcribed.

The first empirical part of the group counselling stage is based on theory of discourse analysis, in which social reality is seen to be constructed by the talk and texts used in social interaction. [17,18] Professional identity is seen as a contextually negotiated phenomenon. [19]

A preliminary analysis of the results revealed two types of results. Often students very actively discussed and sought career opportunities related to their study field, its motives for selection, educational needs, IT-field work profiles and their own IT career expectations, which were the main content areas of the counselling. Sometimes the active role of the counsellors was essential. In any case the sessions seemed to offer a venue for students to learn and share new information and views related to their study field. This provided elements for constructing their own career paths, a process which continues for a longer period.

Another point of view considers the group counselling practice from the perspective of pedagogical interaction. The role of the teacher as a study counsellor seems to include some controversial features in educational settings. The shift from teacher to counsellor is not an easy one. The teacher as a counsellor can still address expectations for teacher-like behavior in group counselling sessions though the main aim is to contribute to the students’ own activity to build cooperation in the peer discussion. One challenge to the development of structured group counselling is to resolve the traditional role expectations of the student and teacher. The teacher needs to make adjustments to his or her thinking. A particular form of negotiation with students about their own activity is also necessary to create a supportive and confidential peer group.

In conclusion, this stage of the study indicated the necessity for a new counselling-based approach in the CS curriculum that has thus far not existed in the field. Both the peer support of fellow students and the counsellors have their own important roles, which offer the first elements for a functional counselling model for CS students as well as IT professionals.

Group counselling has continued in the academic year 2008-2009 and includes additional elements of the client-centred group counselling approach based on the survey results.

### CONCLUDING REMARKS

The results concerning the students’ awareness of IT careers and the benefit they experienced from CS courses indicate that CS curricula designers must seriously consider professional aspects throughout the study paths of the CS-students. The current separation between CS studies and the IT profession might be one factor behind the low motivation of CS students that has led to both student recruitment problems and high drop-out rates.

The study revealed certain unexpected findings. Contrary to common belief, the students can find theoretical courses valuable. On the other hand, they might find pragmatic courses insufficient for the development of their professional skills. These results show that the field of study is not based on self-evident observations. The interplay of course contents and professional motivation cannot simply be explained by the dichotomy of theoretical and useless versus practical and beneficial courses.

In the future, it would also be important to analyze the teachers’ opinions of the professional aspects of CS courses.
and even their own professional awareness. At the same time
we also need to support the construction of student
knowledge of IT professionals’ skill and knowledge profiles.

The first pilot of the group counselling model has
proved to be fruitful both from the viewpoint of
participants and stakeholders and from that of group
counselling research. Further analysis will be carried out
concerning the processes of group sessions and the
experiences of the participants and group counsellors.

The subproject in CS education is part of a larger
research project, and the empirical findings and theoretical
considerations will be discussed later in this context. One of
the future tasks is to evaluate the cultural requisites of group
counselling practices in CS education and create possibilities
to develop a more permanent guidance and counselling
system. This system covers – at its best – the pre-entry
guidance services, the development of entrance exams, the
study and career guidance and counseling along the phases
of the study path and the transition to the working life.

To summarize, the findings of this study suggest the
importance of rethinking CS curricula from the perspective
of career and professional issues. According to our
experiences, we recommend the following possibilities.
Individual courses and their assignments should elucidate
their professional relevance. This can also be done in
theoretical courses like Data Structures and Algorithms. In
addition to strengthening the professional dimension of
individual courses, we can also offer individual modules
dedicated to professional growth, as our example of group
counseling module for first-year CS students shows.
However, careful and functional study and career
counselling requires interdisciplinary research efforts made
in collaboration with CS teachers and pedagogical experts in
career counselling.

In the future, research in CS counselling can also be
applied to develop IT employees’ career counselling.

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